We claim:

1. A method of synthesizing an electric field, the method comprising:

oversampling a representation of the electric field to be synthesized, to determine a plurality of voltage levels to be generated at a corresponding plurality of locations in space; and

applying the plurality of voltage levels at the corresponding plurality of locations.

2. The method of Claim 1, wherein:

a substance is present sufficiently adjacent to the plurality of locations to exhibit a change in refractive index in response to the electric field synthesized by the act of applying.

3. The method of Claim 2, wherein:

the plurality of locations are spaced apart one from another along a predetermined direction; and

the method further comprises passing light, through the substance.

4. The method of Claim 3, wherein:

the electric field is aperiodic in space along the predetermined direction;

at least a portion of the light has wavelengths in a range of 1300 nm to 1700 nm.

5. The method of Claim 4, wherein:

an instantaneous spatial frequency of the changes in the refractive index of the substance due to

presence of the electric field changes linearly with distance along the predetermined direction; and

a magnitude of the change in refractive index is fixed across the distance.

6. The method of Claim 4, wherein:

a magnitude of the change in refractive index of the substance due to presence of the electric field changes with distance along the predetermined direction; and

an instantaneous spatial frequency of the changes in the refractive index is constant.

7. The method of Claim 4, wherein:

a magnitude of the change in refractive index of the substance due to presence of the electric field and an instantaneous spatial frequency of the refractive index both change with distance along the predetermined direction.

8. The method of Claim 3, wherein:

the electric field is periodic in space along the predetermined direction;

at least a portion of the light has wavelengths in a range of 1300 nm to 1700 nm; and

the period in space of a change in refractive index of the substance due to presence of the electric field is linearly related to a wavelength in the range.

9. The method of Claim 8, wherein:

the electric field has a period in space equal to N times half the wavelength that is linearly related, N being an integer greater than zero.

10. The method of Claim 8, wherein:

the magnitude of change in refractive index of the substance is sufficient for a percentage of the portion of light to be reflected.

11. The method of Claim 8, wherein:

the electric field has a period in space greater than or equal to four times the wavelength that is linearly related.

12. The method of Claim 8, wherein:

the magnitude of change in refractive index of the substance is sufficient for a portion of light of the wavelength in the range to be converted from a first mode to a second mode.

13. The method of Claim 12, wherein:

the substance is birefringent; and

the first mode has a first polarization and the second mode has a second polarization.

14. The method of Claim 13, wherein:

the first polarization is transverse electric (TE) and the second polarization is transverse magnetic (TM).

15. The method of Claim 13, wherein:

the first polarization is transverse magnetic (TM) and the second polarization is transverse electric (TE).

16. The method of Claim 12, wherein:

the first mode is opposite in direction of propagation to the second mode.

17. The method of Claim 12, wherein:

the first mode has a first propagation constant and the second mode has a second propagation constant.

18. The method of Claim 12, wherein:

each mode has a different propagation constant; and

the first mode is in a first waveguide, and is physically separated from the second mode in a second waveguide.

19. The method of Claim 1, wherein the plurality of voltage levels is hereinafter "first plurality of voltage levels", and the electric field synthesized by the act of applying has a "first distribution", the method further comprising:

applying a second plurality of voltage levels at the corresponding plurality of locations;

wherein a second electric field synthesized by applying the second plurality of voltages has a second distribution different from the first distribution.

20. The method of Claim 1 further comprising:

subsequent to oversampling, storing in memory a plurality of digital values corresponding to the plurality of voltage levels; and

prior to applying, reading the plurality of digital values from memory.

21. The method of Claim 1 further comprising:

prior to applying, receiving an instruction indicating at least an attribute of the to-be-synthesized electric field.

22. The method of Claim 1, wherein the plurality of voltage levels is hereinafter "first plurality of voltage levels", the electric field has a first distribution in space, and the instruction is hereinafter "first instruction", the method further comprising:

subsequent to the applying, receiving a second instruction indicating a second distribution of a second electric field to be synthesized; and

in response to receipt of the second instruction, applying a second plurality of voltage levels based on the second distribution, at the corresponding plurality of locations.

23. The method of Claim 1 wherein:

the plurality of voltages are applied to a corresponding plurality of electrodes, each electrode in the plurality of electrodes being insulated from another electrode in the plurality of electrodes.

24. The method of Claim 1 further comprising:

prior to applying, receiving an instruction indicating an attribute of the to-be-synthesized electric field.

25. The method of Claim 24 wherein:

the electrodes are separated one from another by an equal distance therebetween, hereinafter "pitch."

26. The method of Claim 25 wherein:

each electrode in the plurality of electrodes has a width equal to 50% of the pitch.

27. The method of Claim 25 wherein:

each electrode in the plurality of electrodes has a length of at least an order of magnitude greater than the pitch.

28. A method of synthesizing an electric field, the method comprising:

determining, based on a mathematical model of the to-be-synthesized electric field, a plurality of voltage levels to be applied at a corresponding plurality of locations arranged one after another in spatial succession, the voltage levels at successive adjacent and non-adjacent locations being applicable independent of one another; and

applying the plurality of voltage levels at the corresponding plurality of locations, independent of one another.

29. The method of Claim 28 wherein the plurality of locations are arranged along a predetermined direction.

30. The method of Claim 29 wherein the plurality of locations are arranged at a spatial frequency greater than two times the highest spatial frequency of the mathematical model of the electric field.

31. The method of Claim 28 wherein the plurality of locations are more than three in number.

32. The method of Claim 28 wherein the plurality of voltage levels are more than three in number.

33. The method of Claim 28 wherein the voltage levels supplied to at least four successive locations differ one from another in value.

34. The method of Claim 28 wherein the voltage levels supplied to at least two successive locations are identical in value.

35. The method of Claim 28 wherein a substance exhibiting a change in refractive index in response to an electric field is located sufficiently close to the plurality of locations to respond to the electric field synthesized by the applying of voltage levels.

36. An apparatus capable of synthesizing an electric field during operation, the apparatus comprising:

a plurality of electrodes positioned successively one after another along a predetermined direction in space, each electrode being electrically insulated from all other electrodes in said plurality; and

a plurality of storage elements encoded with a corresponding plurality of digital values indicative of voltage levels, the digital values being more in number than a minimum number required to represent the highest frequency component in a representation of the electric field distribution from which the digital values are derived;

wherein each electrode in the plurality of electrodes is coupled to a different storage element in the plurality of storage elements.

37. The apparatus of Claim 36 further comprising:

a substance exhibiting a change in refractive index in response to an electric field, located adjacent to the plurality of electrodes.

38. The apparatus of Claim 36 further comprising:

a light source positioned to propagate light into the substance.

39. The apparatus of Claim 36, wherein:

the digital values define the electric field to have a first distribution in space perpendicular to the predetermined direction; and

the apparatus further comprises an additional storage element encoded with an instruction indicating an attribute of a second distribution different from the first distribution.

40. The apparatus of Claim 36, wherein:

the electric field is approximately sinusoidal in space, the approximation depending on the number of digital values.

41. The apparatus of Claim 36, wherein the plurality of storage elements is hereinafter "first plurality of storage elements", the plurality of digital values is hereinafter "first plurality of digital values", the electric field is hereinafter "first electric field", and the additional storage element is hereinafter "first additional storage element", the apparatus further comprising:

a second plurality of storage elements encoded with a corresponding second plurality of digital values, each electrode in the plurality of electrodes

being also coupled to a different storage element in the second plurality of storage elements;

a second additional storage element encoded with an attribute of a second electric field represented by the second plurality of digital values; and

a plurality of multiplexers, each multiplexer having two input ports respectively coupled to a first storage element in the first plurality and to a second storage element in the second plurality, each multiplexer having an output port coupled to an electrode.

42. The apparatus of Claim 36 further comprising:

two reflective surfaces arranged opposite one another to define a cavity;

wherein the plurality of electrodes are positioned to generate an electric field within the cavity.

43. The apparatus of Claim 42 further comprising:

a gain medium located within the cavity;

a mode converter located within the cavity and adjacent to the plurality of electrodes; and

an optical coupler physically between the gain medium and the mode converter.

44. The apparatus of Claim 43 further comprising:

a first anti-reflective coating formed on the gain medium; and

a second anti-reflective coating formed on the mode converter.

45. The apparatus of Claim 43 further comprising:

a first waveguide formed within the gain medium; and

a second waveguide formed within the mode converter

46. The apparatus of Claim 45, wherein:

the optical coupler comprises a lens, a tapered waveguide, or an optical fiber.

47. The apparatus of Claim 43, wherein the mode converter is a polarization mode converter comprises:

a substance of variable refractive index, located sufficiently close to the plurality of electrodes to respond to an electric field generated by the electrodes; and

a polarizing element located adjacent to one of the two reflective surfaces.

48. The apparatus of Claim 47 wherein at least one of the two reflective surfaces (hereinafter "first reflective surface") is partially transmissive, and the apparatus further comprising:

a photodiode physically adjacent to the first reflective surface.

49. The apparatus of Claim 48 further comprising:

a wavelength filter physically between the first reflective surface and the photodiode.

50. The apparatus of Claim 48 further comprising:

an analog to digital converter coupled to the photodiode; and

a computer coupled to receive a signal from the analog to digital converter.

51. The apparatus of Claim 48 further comprising:
a laser diode; and
a package, enclosing the laser diode and the mode converter.

52. The apparatus of Claim 51 wherein:
the package also encloses the gain medium and the optical coupler.

53. The apparatus of Claim 47 further comprising:
an optical modulator coupled to one of the reflective surfaces to modulate light in accordance with a digital or analog waveform.

54. The apparatus of Claim 43, wherein the gain medium comprises:
a semiconductor device.

55. The apparatus of Claim 43, wherein the semiconductor device comprises:
a laser diode.

56. The apparatus of Claim 54, wherein:
the laser diode is a semiconductor device excited by an injection current.

57. The apparatus of Claim 56 further comprising:
driver circuitry capable of modulating the injection current in accordance with an analog or digital waveform.

58. The apparatus of Claim 54, wherein:
the gain medium is a semiconductor device excited by the optical output of a laser device.

59. The apparatus of Claim 43, wherein:
the gain medium comprises a plurality of rare earth ions embedded in a dielectric material.

60. The apparatus of Claim 43, wherein:
the gain medium includes a waveguide having an asymmetric cross-section.

61. The apparatus of Claim 43, wherein:
the gain medium includes a waveguide having artificially induced strain in an active layer.

62. The apparatus of Claim 43 further comprising:
a microprocessor flip chip bonded to the electrodes by an array of solder balls.

63. An apparatus capable of synthesizing an electric field during operation, the apparatus comprising:
a plurality of electrodes, each electrode being electrically insulated from all other electrodes in said plurality; and
a plurality of storage elements encoded with digital values corresponding to a plurality of voltage levels to be applied at the plurality of electrodes, the plurality of storage elements being at least four in number;
wherein each electrode in the plurality of electrodes is coupled to a different storage element in the plurality of storage elements.

64. The apparatus of Claim 63 further comprising:
a substance of a variable refractive index, located adjacent to the plurality of electrodes.

65. The apparatus of Claim 63 further comprising:
a light source positioned to transmit light into the electric field synthesized by the electrodes when the voltage levels are applied.

66. An apparatus capable of synthesizing an electric field during operation, the apparatus comprising:
a plurality of electrodes positioned successively one after another along a predetermined direction with an equal distance therebetween (hereinafter "pitch"), each electrode in the plurality of electrodes having a width equal to 50% of the pitch.

67. The apparatus of Claim 66 further comprising:
a substance of a variable refractive index, located adjacent to the plurality of electrodes.

68. The apparatus of Claim 66 further comprising:
a light source positioned to transmit light into the substance.

69. An apparatus capable of synthesizing an electric field during operation, the apparatus comprising:
a plurality of electrodes positioned successively one after another along a predetermined direction, each electrode being electrically insulated from all other electrodes in said plurality; and

a plurality of storage elements encoded with digital values corresponding to a plurality of voltage levels to be generated by the plurality of electrodes;

wherein the voltage levels supplied to at least four successive electrodes along the predetermined direction are different one from another in value.

70. The apparatus of Claim 69 further comprising:

a substance of a variable refractive index, located adjacent to the plurality of electrodes.

71. The apparatus of Claim 70 further comprising:

a light source positioned to transmit light, into the substance.

72. An apparatus capable of synthesizing an electric field during operation, the apparatus comprising:

a plurality of electrodes positioned successively one after another along a predetermined direction, each electrode being electrically insulated from all other electrodes in said plurality, at least two adjacent electrodes in the plurality of electrodes having different attributes.

73. The apparatus of Claim 72 further comprising:

a substance of a variable refractive index, located adjacent to the plurality of electrodes.

74. The apparatus of Claim 73 further comprising:

a light source positioned to transmit light into the substance.

75. An apparatus capable of synthesizing an electric field during operation, the apparatus comprising:

a substance of variable refractive index; and

a plurality of electrodes positioned successively one after another along a predetermined direction, with an equal distance therebetween (hereinafter "pitch"), each electrode being electrically insulated from all other electrodes in said plurality, the plurality of electrodes being located adjacent to the substance;

wherein during operation a plurality of voltages generated by the plurality of electrodes cause a change in refractive index of the substance along the predetermined direction, the pitch being less than spatial periodicity of the change in refractive index.

76. The apparatus of Claim 75 further comprising:

a light source positioned to transmit light, into the substance.